Unit 2 –Energy & States of Matter – Part 1 - Objectives

1. Relate observations of diffusion to particle motion and collision in the gas and liquid phases.	
2. Relate observations regarding the addition of energy by warming to increased particle motion.	
3. Describe the characteristics of solids, liquids and gases in terms of particles and their: arrangement: use particle diagrams to account for motion and density differences; describe the process of how the arrangement of matter particles changes during phase changes.	
4. Relate temperature to the kinetic energy (E_k) of particles in motion.	
5. Explain, at the particle level, how a thermometer measures the temperature of the system.	

6. Explain the basis for the Celsius temperature scale.	
7. State the basic tents of Kinetic Molecular Theory (KMT).	
8. The 3 variables P, V and T are interrelated. Any factor that affects the number of collisions has an effect on the pressure. You should be able to: • Predict the effect of changing P, V or T on any of the other variables. $P \propto \frac{1}{V} \quad P \propto T \quad V \propto T$ • Explain (in terms of the collisions of particles) *why* the change has the effect you predicted. • Explain the basis for the Kelvin scale. Use the absolute temperature scale to solve gas problems. • Use factors to calculate the new P, V or T. Make a decision as to how the change affects the variable you are looking for.	

Name____________________________________

Date__________ Pd____

Unit 2 Worksheet 1

1. You decide to boil water to cook noodles. You place the pan of water on the stove and turn on the burner.
   a. How does the behavior of the water molecules change as the pan of water is heated?

   b. What about your answer to (a) would change if there were more water in the pan?

2. What property of matter best describes the way a typical alcohol thermometer works? Explain (in terms of energy transfer) why the alcohol level in the thermometer rises (or falls) when you place the thermometer in contact with both warmer (or colder) objects.

3. If you feel feverish, why can't you take your own temperature with your hand?

4. Your older brother announces that the lid to a jar of pickles from the refrigerator is "impossible" to loosen. You take the jar, hold the lid under the hot water from your sink's faucet for a few seconds, and calmly open the jar. Your brother, when faced with this blow to his pride, claims that he loosened it for you. What knowledge of materials have you applied in this situation that really explains how you were able to open the lid?

5. Describe how Anders Celsius devised the temperature scale that bears his name.

6. Which would feel warmer to the touch - a bucket of water at 50˚C or a bathtub filled with water at 25˚C? Which of these contains more energy? Account for any differences in your answers to these questions.

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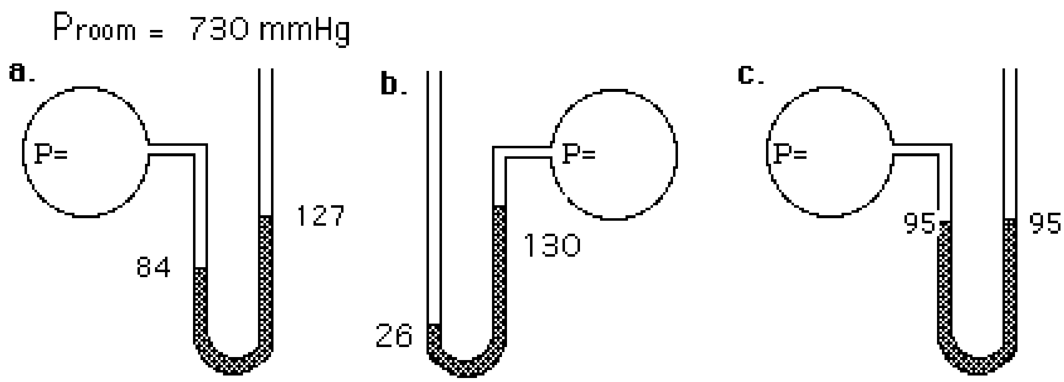
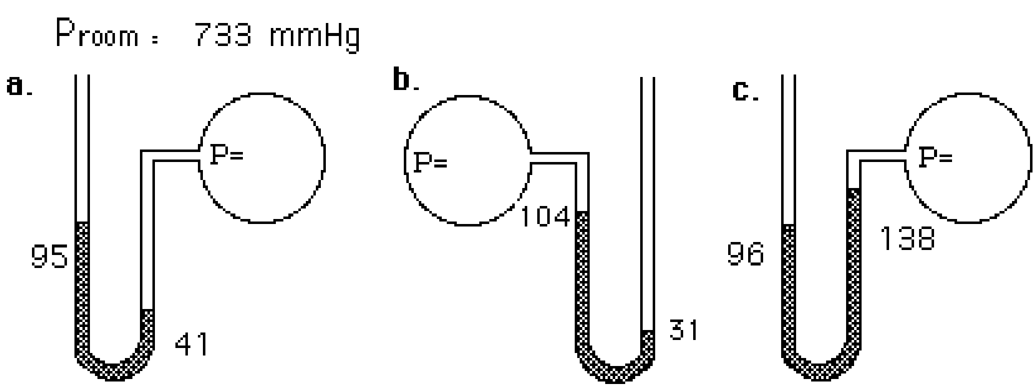
Unit 2 Worksheet 2 - Measuring Pressure

Problems 1 and 2. Calculate the pressure of the gas in the flask connected to the manometer.

1.



2.

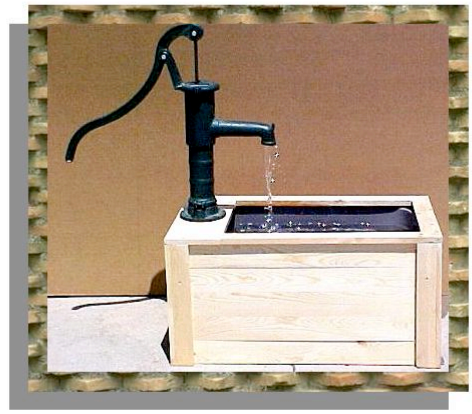


3. What do we mean by atmospheric pressure? What causes this pressure?

4. How do we measure atmospheric pressure? Is atmospheric pressure the same everywhere on the surface of the earth?

5. Why is the fluid in a barometer mercury, rather than water or another liquid?

6. Explain why you cannot use a pump like the one at the right to lift water up to the 3rd floor of an apartment complex.



7. One standard atmosphere of pressure (SP) is equivalent to ________mmHg.

8. Convert pressure measurements from one system of units to another in the following problems.

   1 atmosphere = 760 mmHg = 14.7 psi (pounds per square inch)

   a. 320 mmHg x _____________ = atm

   b. 30.0 psi x _______________ = mmHg

   c. The barometric pressure in Breckenridge, Colorado (elevation 9600 feet) is 580 mm Hg. How many atmospheres is this?

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Unit 2 Worksheet 3 – PVTn Problems

On each of the problems below, start with the given P, V, T, or n; then make a decision as to how a change in P, V, T, or n will affect the starting quantity, and then multiply by the appropriate factor. Draw particle diagrams of the initial and final conditions.

1. A sample of gas occupies 150 mL at 25 ˚C. What is its volume when the temperature is increased to 50˚C? (P and n = constant)

	P	T	V	n
Initial				
Final				
Effect				

2. The pressure in a bicycle tire is 105 psi at 25˚C in Fresno. You take the bicycle up to Huntington, where the temperature is – 5˚C. What is the pressure in the tire? (V and n = constant)

	P	T	V	n
Initial				
Final				
Effect				

3. What would be the new pressure if 250 cm^3 of gas at standard pressure is compressed to a volume of 150 cm^3 ? (_________ = constant)

	P	T	V	n
Initial				
Final				
Effect				

4. What would be the new volume if 250 cm^3 of gas at 25˚C and 730 mm pressure were changed to standard conditions of temperature and pressure? (____= constant)

	P	T	V	n
Initial				
Final				
Effect				

5. Sam's bike tire contains 15 units of air particles and has a volume of 160mL. Under these conditions the pressure reads 13 psi. The tire develops a leak. Now it contains 10 units of air and has contracted to a volume of 150mL). What would the tire pressure be now?

	P	T	V	n
Initial				
Final				
Effect				

6. A closed flask of air (0.250L) contains 5.0 "puffs" of particles. The pressure probe on the flask reads 93 kPa. A student uses a syringe to add an additional 3.0 "puffs" of air through the stopper. Find the new pressure inside the flask.

	P	T	V	n
Initial				
Final				
Effect				

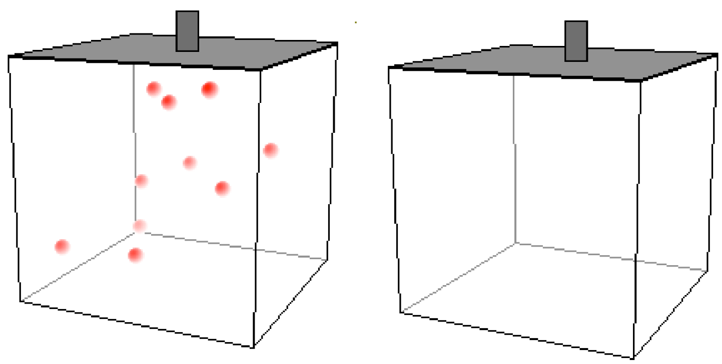
7. A 350 mL sample of gas has a temperature of 30˚C and a pressure of 1.20 atm. What temperature would needed for the same amount of gas to fit into a 250 mL flask at standard pressure?

	P	T	V	n
Initial				
Final				
Effect				

8. A 475 cm^3 sample of gas at standard temperature and pressure is allowed to expand until it occupies a volume of 600. cm^3. What temperature would be needed to return the gas to standard pressure?

	P	T	V	n
Initial				
Final				
Effect				

9. The diagram below left shows a box containing gas molecules at 25˚C and 1 atm pressure. The piston is free to move.



In the box at right, sketch the arrangement of molecules and the position of the piston at *standard* temperature and pressure. Does the volume decrease significantly? Why or why not?

Classwork: Two Gas Laws

Name: ___________________________

Use Boyles' Law to answer the following questions:

Ex.) 1.00 L of a gas at standard temperature and pressure is compressed to 473 mL. What is the new pressure of the gas?

a) **Relationship**:

VOLUME is DECREASING, therefore PRESSURE will INCREASE
(n & T are constant)

b) **Math**: $P_1V_1 = P_2V_2$ or (1 Atm)(1.00 L) = (P_2)(0.473 L)

P_2 = 2.11 Atm

1. In a thermonuclear device, the pressure of 0.050 liters of gas within the bomb casing reaches 4.0×10^6 atm. When the explosion destroys the bomb casing, the gas is released into the atmosphere where it reaches a pressure of 1.00 atm. What is the volume of the gas after the explosion?
   a. **Relationship**:

   _____________ is ____________, therefore ____________will ____________

   (_____ & _____are constant)

   b. **Math**:

2. Synthetic diamonds can be manufactured at pressures of 6.00×10^4 atm. If we took 2.00 liters of gas at 1.00 atm and compressed it to a pressure of 6.00×10^4 atm, what would the volume of that gas be?
   a. **Relationship**:

   _____________ is ____________, therefore ____________will ____________

   (_____ & _____are constant)

   b. **Math**:

3. The highest pressure ever produced in a laboratory setting was about 2.0×10^6 atm. If we have a 1.0×10^{-5} liter sample of a gas at that pressure, then release the pressure until it is equal to 2.0 atm, what would the new volume of that gas be?
   a. **Relationship**:

   _____________ is ____________, therefore ____________will ____________

   (_____ & _____are constant)

   b. **Math**:

4. Submarines need to be extremely strong to withstand the extremely high pressure of water pushing down on them. An experimental research submarine with a volume of 10,000 liters has an internal pressure of 1520 mm Hg. If the pressure of the ocean breaks the submarine forming a bubble with a pressure of 200 atm pushing on it, how big will that bubble be?
   a. **Relationship**:
      ____________ is ___________, therefore ___________will ___________

      (_____ & _____are constant)
   b. **Math**:

Use the Pressure – Number of Particles Relationship to answer the following questions

5. 200 particles are contained in a glass jar with a pressure of 300 mm Hg. If an *additional* 400 particles are added to the jar, what will the new pressure be?
   a. **Relationship**:
      ____________ is ___________, therefore ___________will ___________

      (_____ & _____are constant)
   b. **Math**:

6. A gas containing 300 particles is enclosed in a sealed metal box. The pressure in the box is 1500 atm. A technician lowers the pressure in the box to 500 atm. How many particles are in the box now?
   a. **Relationship**:
      ____________ is ___________, therefore ___________will ___________

      (_____ & _____are constant)
   b. **Math**:

7. The pressure inside a helium tank is lowered from an initial pressure of 20.00 atm to 5.00 atm as the tank is used to fill up balloons. What percentage of the original number of particles still remains in the tank?
   a. **Relationship**:
      ____________ is ___________, therefore ___________will ___________

      (_____ & _____are constant)
   b. **Math**:

A mix and match of problems: *Show your work on another sheet of paper. Be sure to include a statement of the relationship and all the mathematical work necessary.*

8. Part of the reason that conventional explosives cause so much damage is that their detonation produces a strong shock wave that can knock things down. While using explosives to knock down a building, the shock wave can be so strong that 12 liters of gas will reach a pressure of 4.0×10^4 mm Hg. When the shock wave passes and the gas returns to a pressure of 800 mm Hg, what will the volume of that gas be?

9. Atmospheric pressure on the peak of Mt. Everest can be as low as 150 mm Hg, which is why climbers need to bring oxygen tanks for the last part of the climb. If the climbers carry 10.0 liter tanks with an internal gas pressure of 3.00×10^4 mm Hg, what will be the volume of the gas when it is released from the tanks?

10. A collection of 1000 gas particles is enclosed in a lightbulb at 1.00 atm. Before the lightbulb is sealed off, particles are drained out until the pressure is reduced to 152 mm Hg. How many particles remain in the lightbulb?

11. Divers get "the bends" if they come up too fast because gas in their blood expands, forming bubbles in their blood. If a diver has 0.050 L of gas in his blood under a pressure of 264 atm, then rises instantaneously to a depth where his blood has a pressure of 4.0×10^4 mm Hg, what will the volume of gas in his blood be? Convert your answer to milliliters. Compare this volume to a soda can. Do you think this will harm the diver?

12. A strong metal tank with a volume of 0.500 mL contains 2.50×10^{-4} g of a gas at 1.00 atm. A pump is attached to the tank and the pressure is tripled. What is the density of the gas at the new pressure?

Answers:

1) 2.0×10^5 L
2) 3.33×10^{-5} L
3) 10 L
4) 100 L
5) 900 mm Hg
6) 100 particles
7) 25%
8) 600 L
9) 2.0×10^3 L
10) 200 particles
11) 251 mL
12) 1.5×10^{-4} g/mL

Chemistry – Unit 2 Review

To prepare to do well on the chapter 2 test, you should assemble your notes, the 3 worksheets and the quiz and review them, preferably in a small group where you can draw from each other's understanding. Here are the key points you should know.

Energy

Think of energy as a quantity that is always involved when there is a *change* in the state of matter. When a substance gets hotter or colder or changes phase, energy is either transferred into or out of the system. One way energy is stored in a system is **kinetic energy** (due to the motion of the particles). As particles move faster, their kinetic energy increases. As the particles move faster, they tend to move farther apart from one another. Temperature is a measure of the kinetic energy of the system.

1. Explain why the alcohol level in a thermometer rises when it is placed in a warmer fluid. (3-step process)

2. Explain why the alcohol level in a thermometer falls when it is placed in a cooler fluid. (3-step process)

3. Explain how the Celsius scale was devised and why it is not appropriate to use it when describing the behavior of gases. (review ws 1, PVTn lab)

Kinetic Molecular Theory

This theory describes all matter as being composed of tiny particles in endless random motion. In a solid, the particles vibrate, but are locked into an orderly array. In a liquid, the particles are still touching but are free to move around past one another. In a gas, the particles are moving very rapidly and are widely separated. Using a particle diagrams, represent samples of a cold gas and a hot gas.

Gas behavior

Gas pressure is a measure of the collisions of the molecules with the sides of the container. A barometer is used to measure atmospheric pressure; a manometer is used to measure the pressure in a container. (review ws 3)

The 3 variables P, V and T are interrelated. Any factor that affects the number of collisions has effect on the pressure. You should be able to:

4. Predict the effect of changing P, V or T on any of the other variables.

$$P \propto \frac{1}{V} \qquad P \propto T \qquad V \propto T$$

5. Explain (in terms of the collisions of particles) why the change has the effect you predicted.

6. Explain why one must use the absolute temperature scale to solve gas problems.

7. Use factors to calculate the new P, V or T (review ws 3). Make a decision as to how the change affects the variable you are looking for.

8. Suppose that you lowered the temperature of a gas from 100˚C to 50 ˚C. By what factor do you change the volume of the gas?

9. Suppose that 25.0 mL of a gas at 725 mm Hg and 20˚C is converted to standard pressure and temperature. What would be the new volume?

10 Find your copy of The Model so Far and note what modifications in our particle model of matter we have made in this unit.